

harvest (fig. 15, reproduced in fig. 2) were used with a new set of dates to make a map of the advance of autumn. Local modifications were necessary to allow for the effects of the Great Lakes and Atlantic Ocean. Such a map may be used as a general basis for "safe" wheat seeding, because the development of the Hessian fly is closely dependent on late-summer and autumn weather.

The lines were dated and modified in "an attempt to correlate the recommendations of the different experiment stations as to the date of seeding winter wheat. The results of experiments in Kansas, Nebraska, Iowa, Indiana, and Ohio show that when the Hessian fly is prevalent the best yields may be expected when the seeding occurs just after the emergence of the last autumn brood of the fly; and when the fly is not numerous, the best time for seeding generally is about a week earlier. In the years when the fly is prevalent the actual dates to be recommended depend on experiments in the fields at the time, so in such years it is necessary to follow closely the recommendations of the State entomologists. Planting in the North depends largely on the season and the labor situation. South of the thirty-ninth parallel and east of southeastern Kansas the autumn is long enough to allow seeding after the average date of emergence of the fly, with the best chance of still securing the maximum yield." The altitude-latitude table inserted in the map represents the reverse of the latitude and altitude rate of progress of winter-wheat harvest, which progresses about a degree of latitude or 400 feet of general altitude in 4 days.

As Dr. Hopkins points out, there are many other ways in which the maps showing the actual dates of operations can be used as a basis for improving farm practice and for determining the best regions for expanding the average of different crops.

Supplementing these isochronal maps, are 17 "dot" maps showing the acreage distribution of the crops mentioned. Two maps show the regions where corn is cut and shocked, and where corn is jerked from standing stalks. Two graphs show the production of early and of late potatoes by date of harvest zones. The applications to farm management and farm labor problems are brought out in detail by graphs showing the hours devoted to different farm operations by 10-day periods throughout the year at seven typical farming regions of the United States. There are three large dot maps showing the distribution of farmers, of farm laborers, and of expenditure for labor.—C. F. Brooks.

DUFRENOY'S OBSERVATIONS OF THE TEMPERATURES OF PLANTS IN SUNLIGHT AND SHADE.

The difference in the temperature of plants in direct sunshine and in shade, and the action of the pigments in varying the temperature of different colored leaves and plants in sunshine, is shown in a recent article by the French naturalist Mr. J. Dufrenoy, of the biological station at Arachon, in the *Revue Générale de Sciences*.

He explains the formation of the pigments in plants, and the increase or decrease of pigmentation with varying heat, moisture, and sunshine values, then shows the effect of these different pigments in the absorption of solar energy.

We quote the following from a recent review of this article in the *Scientific American Supplement* for February 15, 1919:

* * * The solar energy absorbed by the pigments is largely converted into heat. In January at Arachon, on a fine day, the temperature of the plants exposed to the sun exceeds that of the air by from 6° to 8° C. at noon, and by from 12° to 15° C. at 3 p. m.; the amount of this rise in temperature varies according to the color and to the intensity of the pigmentation, so that a difference of more than 1° C. may exist between the yellow and the green leaves of the variegated foliage of a spindle tree, or even between the two borders of a single variegated leaf.

Experiments made in January at Arachon gave the following results: In a variegated leaf of the *Iris pallida* the green portion showed a rise in temperature of 9.8° C. over that of the air against a rise of only 8.5° C. in the yellow portion. Similar observations were made with the red and green leaves of an arbutus, the time being 10 a. m. and the temperature of the air 10° C.; in this case the red leaf showed a rise of 7.5° C. and the green leaf a rise of only 7° C.

* * * In November tests were made at 2 p. m. with red and white arbutus berries, the temperature of the latter being 29.5° C. and that of the red one degree higher.

Finally experiments were made with grapes of various colors placed in sunshine and in shade. The temperature of the red grapes in the sun was 37° C. and 10° C. less in the shade; that of white, green, and amber colored grapes was 34° C. in the sun, and 28° C. in the shade. The time of this last experiment was October 10, at 3 p. m., the temperature of the air being 24° C. in the shade. A second experiment showed that grapes with a dull surface had a temperature of 35.5° C. in the sun, whereas that of those with a bright surface was 34.8° C.

A highly interesting fact is that every rise of 10° C. in the temperature of the organs exposed to sunlight doubles or even trebles the rapidity of the reactions observed—for example, the intensity of respiration is greatly enhanced, more carbon dioxide being liberated.

In fruits exposed to sunlight the plant acids contained are reduced, and the ripening is correspondingly hastened. * * *

These experiments illustrate the difficulty in making comparable records of the temperature of plants in sunshine as made by different investigators, or by the same man at different times.—J. Warren Smith.

NOTE ON THE HEATING OF PLANTS IN SUNLIGHT AS A FACTOR IN GROWTH.*

By D. A. SEELEY, Meteorologist.

[Dated: Weather Bureau, Lansing, Mich., May, 1919.]

The results of M. Dufrenoy's observations on the temperature of plants, as quoted above, offer further evidence of the importance of sunshine in plant growth. Differences of 12° to 15° C. (22° to 27° F.), noted by M. Dufrenoy between leaf and air temperature on clear days, are not in excess of those observed by several other investigators at various times. Such large temperature differences must surely produce marked metabolic activities in the plant, not to mention the actinic influences. The fact that under sunshine plants are so much warmer than the air should be given more consideration in studies of the relationship between weather conditions and plant growth. In the past it has been the custom to study air temperature in relation to plant growth without considering the often widely different temperature of the plant itself, especially in sunshine. The "Summation method," by which the excess of air temperature above a given limit is computed, gives widely divergent results when worked out for a given life phase of plants in different years, largely on account of the failure to take into consideration the difference between plant and air temperature. When the sun is shining the air temperature does not register the true thermal con-

* Cf. "Crops and temperature," *Abs. in Mo. WEA. REV.* 1917, 45: 354-359.